200408 Rev D

Instructions for Continued Airworthiness

EARTHX ETX680-24-TSO BATTERY, PART 23 APPROVED MODELS LIST INSTALLATION

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Revision Log

Rev	Description	Date	Approved By:
New	Created New	9/26/2023	Nicoson
A	Revised per FAA comments (ref. 773 24 00018), and subsequent FAA OMT comments.	3/6/2024	Nicoson
B	p. 9: "AC 43.13-1B" was "AC 43.13-2B". p. 11: Added placard part number and larger image of placard. p. 16: Added figure 10 to show battery top label. p. 18: Clarified over-discharge disconnect.	5/1/2024	Nicoson
C	p. 8; Section Installation, Install Requirements. Removed Note – "***Note:*** *Aircraft certificated in the Utility Category are not eligible for this installation.*"	6/10/2024	Nicoson
D	Clarified Titles; removed initial installation discussion.	7/11/2024	Nicoson

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Cert Works LLC, ODA
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ICON KEY

Valuable information

Caution

Warning

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Airworthiness Limitations

The Airworthiness Limitations section is FAA approved and specifies maintenance required under Secs. 43.16 and 91.403 of Title 14 of the Code of Federal Regulations unless an alternative program has been FAA approved.

There are no new (or additional) airworthiness limitations associated with this equipment and/or installation.

FAA APPROVAL:

REVISION	DATE	APPROVED
D	JUL 3 1 2024	Kreg R. Voorhies, ODA administrator Cert Works ODA ODA(AIR)-833987-NM

Introduction

This manual covers the installation, inspection, and maintenance (charging) aspects for the ETX680-24-TSO battery installed on 14 CFR Part 23 aircraft. Installation of the rechargeable lithium battery defined herein, meets the guidance of AC 20-184. In accordance with Federal Aviation Administration (FAA) Advisory Circular (AC) 23.1309-1E and FAA Technical Standard Order (TSO) TSO-C179b, the Failure Condition Classification (FCC) for this TSO Battery is "Major" - unless other installations deem the analysis lessor or greater, dependent on the function(s) in the installation.

Although many internal and external safety features have been designed per TSO-C179b and AC 20-184, failure to follow all application use, installation, charging, and storage instructions may result in battery damage and could lead to fire!

Abbreviations

The following table describes the terminology used in this document.

Table 1 Acronyms and Abbreviations

AC	Advisory Circular / Alternating Current
Ah	Amp-Hour is a unit of measure of charge that can be stored in a battery.
AFMS	Airplane Flight Manual Supplement
AML	Approved Model List
BMS	The Battery Management System refers to the collection of electronics responsible for monitoring and protecting the battery cells.
Cell	A single encased electrochemical unit (one positive and one negative electrode) which exhibits a voltage differential across two terminals.
CFR	Code of Federal Regulations
DAL	Design Assurance Level (DAL), as defined by the RTCA
DC	Direct Current
FCC	Failure Condition Classification
GPU	Ground Power Unit
HMR	Hazardous Materials Regulations
ICA	Instructions for Continued Airworthiness
LED	Light Emitting Diode
LRU	Line Replaceable Unit
OEM	Original Equipment Manufacturer
OVPD	Over-Voltage Protection Device
RTCA	Radio Technical Commission for Aeronautics
SDS	Safety Data Sheet
STC	Supplemental Type Certificate
TSO	Technical Standards Order

ICA Revisions

When a revision to the Instruction for Continued Airworthiness (ICA) is necessary, the STC holder will coordinate changes with the FAA. Revisions to the ICA will be available from the documentation section of the EarthX Website: https://earthxbatteries.com/.

Description

EarthX Lithium batteries are designed as a maintenance free replacement for the 24-volt lead-acid or lithium starter batteries. The battery operation is automatic (no operator control). The ETX680-24-TSO battery is part of the main aircraft electrical system with the alternator being the primary power source and the battery being the secondary power source. This battery includes a thermal run-away containment system. The containment system includes a vent tube designed to carry vapor or smoke to the exterior of the aircraft in the extremely improbable event of a thermal run-away condition. There are no emissions during normal operation.

The battery can be mounted and operated in any orientation and operate at high g loads (see specification section).

Specification

Table 2 Battery Specification

Voltage	26.4 V
Capacity (1C, 1hour rate at 23°C)	11.7Ah @ 1C rate (See below)
Capacity vs Temperature	23 °C = 100% 0°C = 97% -30°C = 95% (11.3Ah at this temperature)
Self-Discharge Rate	<3%/month @ 25°C
Peak Power (Ipp), 23/-18 °C	850 / 400 amps
Rated Power (Ipr), 23/-18 °C	500 / 250 amps
Max Continuous Discharge Amps (discharging 100% of capacity)	24A
Standard Charge Voltage	27.6 – 28.8 V
Recommended Charger/Maintainer Amps	5 - 15A
Max Charge Amps	70A (from aircraft charging system)
Rated Life (recommended, not life limited)	6 Years
Weight	7.2lb (3.27Kg)
Dimensions	6.5in (L) x 5.1in (W) x 6.6in (H) 166mm(L)x129mm(W)x168mm(H)
Environmental Rating (resistance to water intrusion)	IP 66 (wash down with a high-pressure washer)
Operating Temperature (short term)	-30 °C to +60 °C (+65 °C for 30minutes)
Storage Temp	-40 °C to +70 °C
Short Term Ground Survival Temp	85 °C (30 minutes)
Maximum Altitude	25,000 Ft
Operational and Crash Safety G Load	20g
Shelf Life	1 year (without charging)
FAA Technical Standard Order	TSO-C179b

Design Assurance Level (DAL), per DO-254	C (major)
Flammability Rating (case and vent tube)	14 CFR 25.853(a)

Dimensions

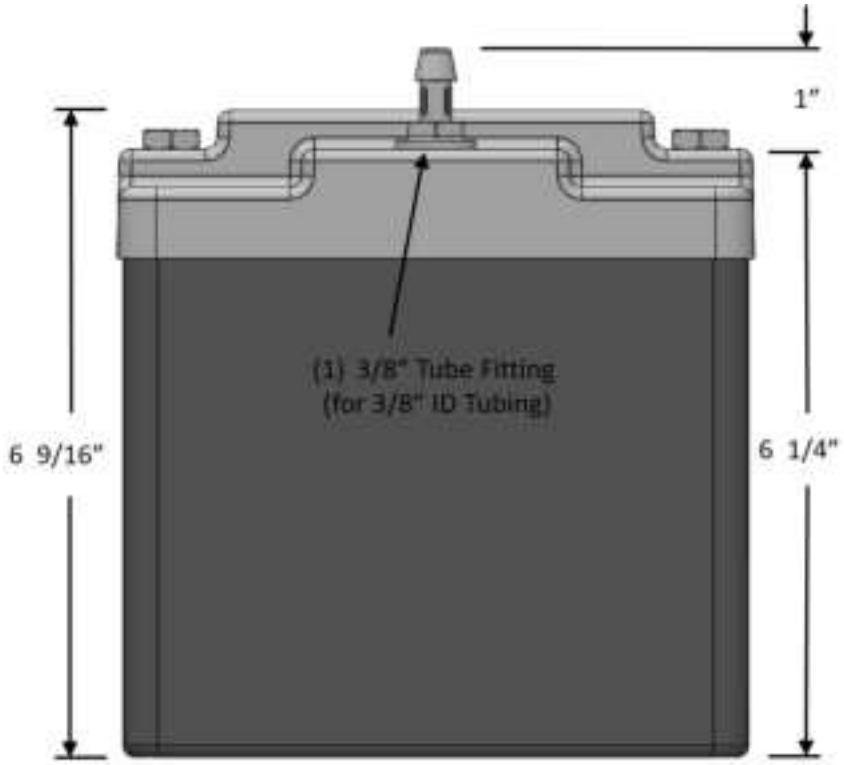

Figure 1 Battery Dimensions - Back View

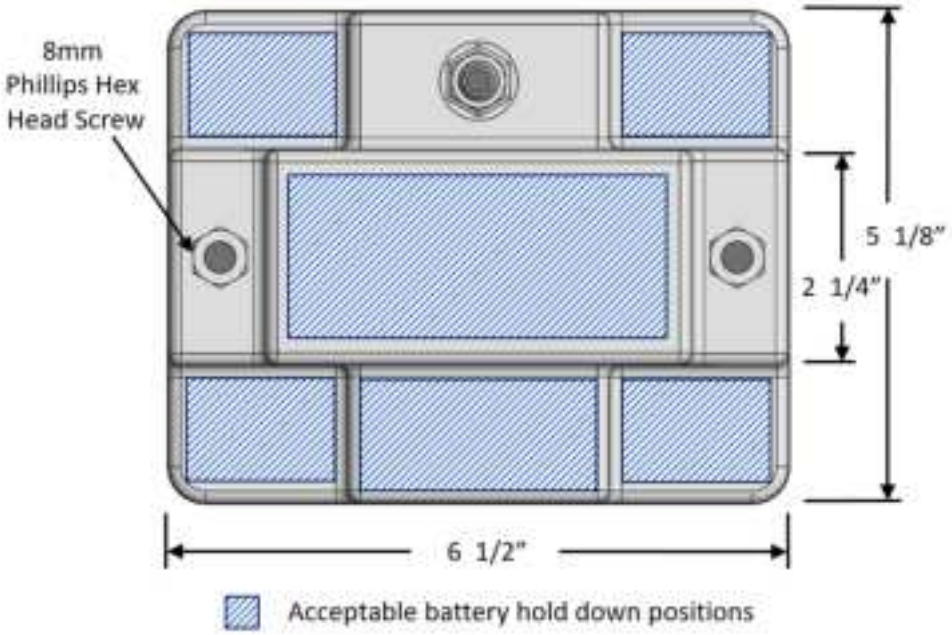

Figure 2 Battery Dimensions - Top View

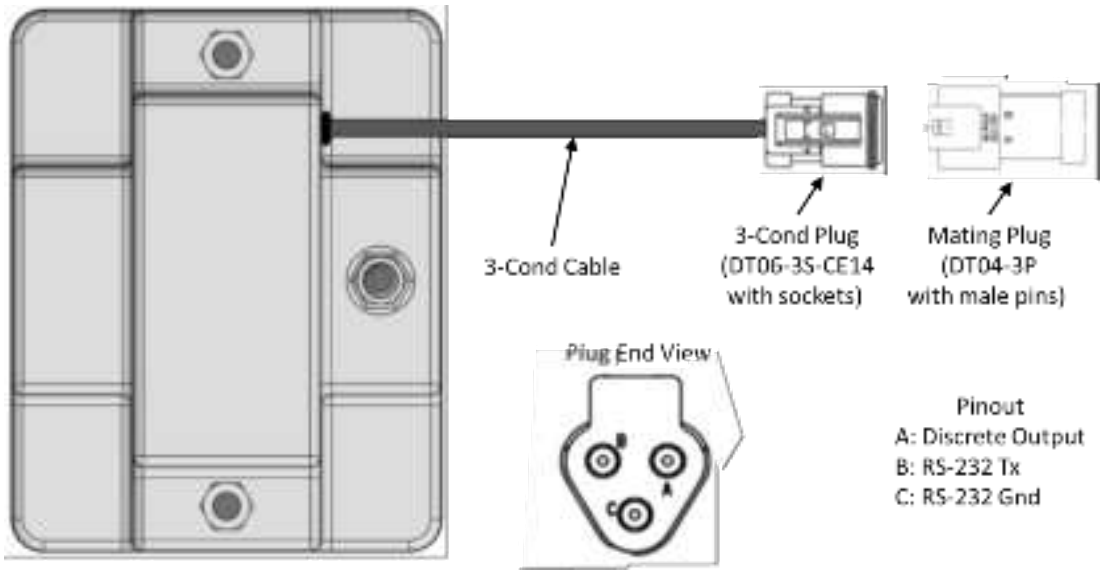

Figure 3 Fault/Status Monitoring Output

Maintenance Removal and Installation

Install Requirements

"This article meets the minimum requirements of technical standard order (TSO) C179b. Installation of this article requires separate approval." The article may be installed only according to 14 CFR part 43 and the Supplemental Type Certificate (STC) requirements. Below are the installation specific, in-service requirements and is not part of the TSO article (LRU) specific certification under TSO-C179b:

a. An automatic Over-voltage Protection Device (OVPD), as part of the aircraft's charging system, is required. Do not install battery if the aircraft does NOT have an OVPD.

b. The battery fault/status monitoring indicator must be installed and tested per this manual.

c. The battery vent system must be installed per this manual.

d. The battery must be secured in a battery box or battery holder as detailed within this manual.

e. The aircraft model and serial number must be eligible for installation IAW the limitations and conditions of STC SA01134DE. Aircraft must be eligible IAW the Approved Model List for this STC.

Remove all metal objects from your person before handling the battery and use insulated tools for installation.

The power terminals are ALWAYS live. Do not short across the terminals. Use caution when handling the battery inside the aircraft around metallic structures.

Battery Removal (Maintenance)

1. Access the battery compartment.
2. Disconnect the battery cables (remove the negative cable first).
3. Remove the tie down hardware, store for reuse.
4. Remove the tie down bar, store for reuse.
5. Disconnect the vent tube at the battery.
6. Remove the battery by lifting out of the battery tray.

Battery Installation (Maintenance)

It is recommended you check the voltage before installing. If the voltage is below 26.4V, charge the battery before installing. Follow these steps to install battery (reinstallation or after service). Qualified personnel should inspect the box, connections, and venting provisions in accordance with AC 43.13-1B Section 2. STORAGE BATTERIES (refer to paragraph 11-19). Refer to the Appendix for battery mounting and install kits for specific aircraft models.

1. Access the battery compartment.
2. Place battery in battery tray.
3. Reconnect the vent line.
4. Place the tie down bar over the battery.
5. Secure battery and tie down bar with the tie down bar hardware.
6. Connect the positive (red) cable first. Make sure the terminal screw is securely fastened (55in-lbs), but do not over-tighten. Next, connect the negative (black) cable. Do not connect the battery in reverse polarity (positive to negative or negative to positive).

Battery Vent Removal (Maintenance)

1. Access the battery compartment.
2. Disconnect the vent at the battery.
3. If necessary, loosen clamps securing the vent line to the airframe.
4. Pull hose up, if necessary, disconnect 3/8" elbows in line.

Battery Vent Installation (Maintenance)

1. Access the battery compartment.
2. Feed the vent line down the existing (original battery drain tube) and route to bottom of firewall, ensure long edge of tube is forward (see figures 4 and 5 below).
3. Replace 3/8" elbows, if removed during removal, and route vent line across top of battery.
4. Connect vent line to battery vent port fitting.
5. Secure clamps holding the drain tube or vent line to the firewall.

Be careful not to crush or restrict flow through the tubing.

Only EarthX supplied tubing and tube fittings should be used.

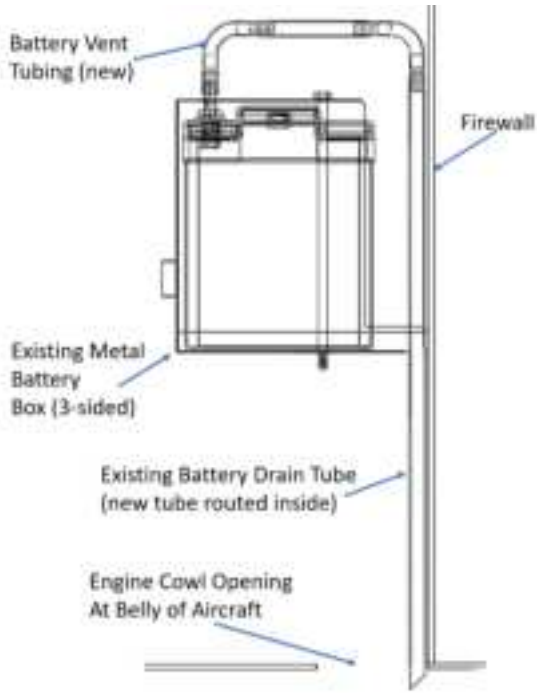

Figure 4 Battery Vent Installation

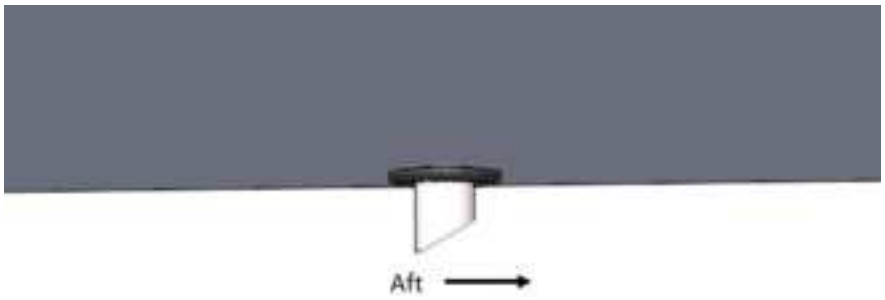

Figure 5 Battery Vent Tube Cut Example

Fault/Status Indicator Removal (Maintenance)

1. Locate the indicator on the instrument panel.
2. Remove the LED bezel, by turning counterclockwise. To replace the LED bulb, slide it out of the bezel (T1 3/4 Midget Flange type bulb).
3. To remove the entire fixture, remove the jam nut on the front side of the panel, and push the LED fixture out the back of the instrument panel.
4. Disconnect the electrical connects at the terminal rings.
5. To remove the fuse, push the ends of the fuse holder together and ¼ turn counterclockwise (¼ x 1 ¼", 1 amp, fast blow fuse).

Fault/Status Indicator Installation (Maintenance)

1. Locate the LED indicator hole on the instrument panel.
2. Insert the LED fixture from the back side of the instrument panel.
3. Install the jam nut on the front side of the fixture to secure in place. Install the bezel onto the LED fixture.
4. Connect the electrical wires as shown in figure 6 below.

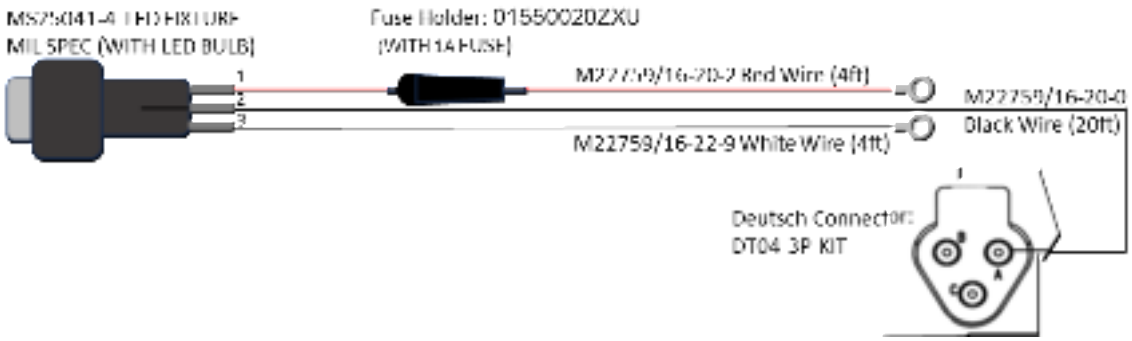

Figure 6 Fault / Status Indicator

Return to Service Checks

Follow these steps to check the battery operation prior to returning to service:

1. Verify the vent tube protruding from the aircraft can NOT be pushed up and into the interior of the aircraft with the force of an index finger.
2. Apply power to the aircraft via master switch, observe proper voltage, greater than 26V.
3. Verify the battery Fault/Status LED is off (no faults).
4. Press the LED "push-to-test lens" and observe the LED illuninates (if equiped).
5. At the battery, jumper the fault/status discrete output to battery negative terminal using a test clip and verify panel LED indicator is "On".
6. Verify engine starts as normal.

Inspection

The supplemental Instructions for Continued Airworthiness (ICA) are required by 14 CFR part 23 for this Article (Part) installed on Aircraft (14 CFR 23.1529 for this application and TSO).

Battery Inspection Intervals

Battery:

Upon installation, record the next battery inspection due date based on the battery age as follows:

- 0-24 months: The battery must be inspected on or before the date the battery turns 24 months old.
- 24+ Months: If the battery was inspected at Annual Inspection, the due date for the next inspection is at the next annual inspection. If the battery was inspected at a time other than annual inspection, inspect the battery no later than 12 months after the last inspection date.

Charging Systems:

Annually: An annual inspection (check and/or test) is required for the voltage regulator and OVPD of the aircraft charging system for safe operation of the battery and aircraft electrical system.

Battery Inspection Instructions

The ETX680-24-TSO battery is a maintenance free battery with no internal replaceable components. No inspection or testing is required for the first 24 months after purchase. Thereafter, an annual inspection is required to ensure that the battery functions as designed and installed for safe operation of the aircraft.

The following inspections/tests shall be performed:

1) Visually inspect the battery for signs of damage; plastic case cracks, warped plastic or long side of the battery is swollen. Replace if damaged.
2) Verify the battery fault/status monitoring LED is operational (not required for digital communications). To do this, use a wire jumper to connect the fault/status discrete output (which connects to the remote LED) to battery ground, and verify the LED is lit.
3) Ensure the battery is fully charged. Turn off the aircraft master switch and any other battery loads, then measure the voltage at the battery terminals. A fully charged battery should be 26.6 volts or greater. If not, charge the battery (see section below).
4) After fully charging the battery in the previous step, allow the battery to rest over-night (minimum of 12 hours) without any load applied to the battery. Verify the battery is "holding a charge" by confirming the voltage is greater than 26.6 volts.
5) Verify the battery capacity. A battery's current capacity as compared to its original capacity is an indication of the battery's remaining service life. A battery with greater than 80% of its original "rated" capacity is considered fit for continued service. If the battery capacity is less than 80%, then it must be replaced. Alternately, if the batteries tested capacity is capable of supporting the aircraft's emergency load for the required

amount of time it is consider fit for continued service. It is recommended that the battery be replaced after 6 years of service. To test the battery capacity:

a. Fully charge the battery
b. Turn on all electrical loads for flight operation and start a timer.
c. Measure and record the battery's discharge amps using a DC clamp-on current meter at the positive terminal of the battery.
d. Using the measured amps in the previous step and the battery's nameplate rated capacity (in Ah), calculate the time to discharge the battery 80%.

$$\text{Time to discharge 80\% (Hours)} = \frac{Rated\ Capacity\ in\ Ah * .8}{Measured\ Discharge\ Amps}$$

For Example, (11.7 Ah Rated Capacity, 8 amp measured discharge rate)

$$\text{Time to discharge 80\%} = \frac{11.7 * .8}{8} = 1.17 \text{ hours}$$

e. Terminate the test after the number of hours calculated in the previous step has expired or if the battery is over-discharged (shuts off discharge current). If the battery is still supplying power at the termination of the test, then the battery's capacity is greater than 80%. If the battery's capacity is greater than 80%, then the battery has passed the test.
f. Fully charge the battery.

6) Verify battery terminals are clean and terminal screws are properly secured (torque to 55in-lbs).
7) Visually inspect the vent tubes to ensure they are not blocked (plugged, pinched, or kinked). Replace if damaged.
8) Verify the battery box and or battery restraint system is in good working order.
9) Test complete, record in Aircraft Logbook with inspection info or storage log.

Aircraft Charging System Inspection Instructions

An annual inspection (check and/or test) is required for the voltage regulator and OVPD of the aircraft charging system for safe operation of the battery and aircraft electrical system. The regulator and OVPD may physically be separate devices or in a single housing. Follow the regulator and/or OVPD manufacturer's ICA or maintenance instructions for periodic checks.

Maintenance

This is a maintenance free battery with no internal replaceable components. Charging is only required as needed.

The following conditions indicate battery end-of-life, and the battery shall be replaced:

- Insufficient capacity per inspection requirements above
- Insufficient power to crank engine.
- On-going battery fault indication (refer to the "Troubleshooting" section)
- Will not hold a charge (<26.6 volts a week after charging the battery to full charge)

At battery end-of-life contact EarthX. The only approved replacement lithium battery is an EarthX battery of the same model number. The model number is displayed on the top label of the battery.

Configuration Control

The battery "Configuration Control" information is on the back side battery label (revision, TSO number, manufacturing date and serial number).

Figure 7 Example Battery Label

Battery Replacement Instructions (Replacement of Existing Battery)

1. Remove the old battery, while paying attention to the routing and placement of wires, cables, spacers, vent tube and protective covers.
2. Check the battery cables and connectors for corrosion or damage. Pay special attention to the positive battery cable (red cable), checking for cuts or wear marks in the insulation. Clean and or replace the battery cables as required in accordance with the basic aircraft maintenance manual.
3. Position the new battery in the existing battery tray or battery box.
4. Connect the positive (red) cable first. Make sure the Phillips screw is securely fastened (55in-lbs), but do not over-tighten. Next, connect the negative (black) cable. Do not connect the battery in reverse polarity (positive to negative or negative to positive).
5. Re-connect the vent tube to the battery vent barbed fitting. To ensure a tight connection, replace the vent tube or cut ½" off the end of the vent tube. If vent tube replacement is required, refer to the "Battery Vent Installation" section of this document.
6. Re-connect the battery fault/status monitoring plug.
7. Re-install the battery hold down or battery box cover and tighten securely. Re-secure all the wires and cables.

Battery Charging

If at any time the aircraft will not start, or the battery seems low, or the voltage is less than 26.4 volts, charge it. To charge the battery, connect an Optimate TM281 (5 amp) battery charger (or other authorized charger) to the battery and leave the charger "On" until the charge lights (Save, Charge and Optimize LEDs in the center of the charger) are extinguished.

The recommended and maximum charge rate is specified on the top label of the battery. Never exceed the maximum charging amps for your battery.

Figure 8 Example Battery Top Label

This table shows typical charging times for the battery:

Table 3 Typical Battery Charging Time

Model	Charging Amps	Charging Time
ETX680-24-TSO	5 amp (TM281 Charger)	3 hours

Lithium batteries have a very low self-discharge rate which means the battery, if disconnected from the aircraft, could "hold its charge" for over a year. However, some aircraft may have systems that use a small amount of power with the "Master switch" off. In those cases, we recommend disconnecting a battery cable from the battery during long term storage (greater than 6 months).

Only an approved battery charger shall be used, see EarthX website for compatible chargers. EarthX approves of the following chargers:

Optimate TM281 (5 amp)

If the battery has been over-discharged and "disconnected"(meaning automatic electronic disconnect commanded by the Battery Management System), the voltage at the battery terminal should be near zero volts if the battery still has a load on it. If the battery is disconnected from the load, it will automatically reconnect, and the terminal voltage should return to > 20 volts (remove the load by removing the positive or negative cables from the battery). In this case, simply connect the battery to a charger to restore charge (charge with 1-10 amps for 20-30 minutes). If the battery is holding a charge (voltage not decreasing over 10-minute period), the battery is ok to fully charge. If the battery voltage does not return to >20 volt after removing all loads, then (step 1) connect the Optimate battery cables to the battery (red clamp to positive and black clamp to negative), next (step 2) plug the charger power cord into AC outlet. The charger should startup and go into the "Save" charging mode. If not contact EarthX technical support.

If using a Ground Power Unit (GPU), the current rating or current setting SHALL NOT be more than the max charge rate stated on the battery label or in this manual. It is recommended that a warning label is placed next to the GPU plug stating the max current allowed.

Never charge a faulty battery (a battery that will not accept a charge or hold a charge).

Never use the de-sulfate setting on your charger.

If the battery gets hot while charging, discontinue charging and use.

Do not charge battery in temperatures above 140 degrees F (60C), or in direct sunlight.

When charging a battery outside the aircraft, place it on a non-flammable surface, and remove any flammable items nearby.

Troubleshooting

The battery is an integral part of the aircraft electrical system and as such to is useful to know the aircraft electrical system voltage and or current at the time of the battery fault.

The Voltage/Current column in the table below lists the voltage/current level or condition that could correspond with the battery fault. For example, over-voltage is an electrical system problem and may be reported and addressed with other aircraft equipment.

The table below is a summary of the battery's fault/status codes (discrete output).

Table 4 Battery Fault / Status Codes

LED Light	Voltage	Possible Cause	Recommended Action
Slow Flashing (5s on/5s off)	Less than 25.5V	Battery over-discharged due to faulty charging system (alternator) not charging the battery.	Charge the battery. Verify aircraft charging system is functioning.
Slow Flashing (5s on/5s off) (> 1 hour)	25.5-29V	Weak or failing cell	Charge the battery with an approved charger and observe fault LED. If LED persists, charge the battery a second time. If the LED fault persists, the battery should be replaced.
Slow Flashing (5s on/5s off)	Greater than 31V	Over-charging (due to faulty charging system regulator)	Verify aircraft charging system is functioning properly; could be faulty voltage regulator and or over-voltage protection device.
Solid Light	Any voltage	BMS electronics issue	Isolate the battery from the aircraft (disconnect positive or negative cable). If the fault is not extinguished, the battery should be replaced.
Solid Light that turns off after 3 minutes	Any voltage	Short Circuit protection was activated	Verify normal voltage (25.5-29V) at the battery terminals. Battery can be returned to service.
Short Flashing (2s on/2s off)	Any voltage	Battery temperature very high (> 85°C / 185°F) due to environment or excessive discharge.	If due to excessive discharge amperage, let the battery cool down prior to cranking or charging. If the environmental temperature is too high, engineer means to cool battery when in service.

For additional information go to https://earthxbatteries.com/ and review the FAQs.

Battery Storage and Handling

If the aircraft is to be put in storage for an extended period (> 6 months), disconnect the battery cable to eliminate drain from the Aircraft's electrical system. A fully charged battery can be put in storage for up to a year without charging but should be charged and inspected annually.

Our batteries can be stored at temperatures between -40°C to +70°C. Our batteries have no liquid inside and will not freeze.

Special care must be taken in the handling, shipping, and storage of rechargeable lithium batteries. As a result, installers, end users, and personnel involved in the maintenance and disposal of rechargeable lithium batteries require training in the special characteristics related to rechargeable lithium battery safety. Leaving battery output terminals or leads exposed may result in external short-circuiting of the battery during shipping, handling, testing and installation. Terminals of batteries shall be covered with non-conductive protective devices to avoid any possibility of shorting during handling, shipping, and storage.

Batteries can be recycled at any location accepting lithium-ion type batteries. Drain battery and or cover terminals with electrical insulating tape prior to recycling. For recycling information and where to recycle check this website (https://www.call2recycle.org/).

Do not incinerate or expose to open flames!

The Safety Data Sheet (SDS) is available on EarthX's website.

Always follow the manufacturers recommended safety precautions and procedures.

Weight and Balance

The installation of the ETX680-24-TSO battery is considered a permanent installation. The basic aircraft weight and balance should be updated inclusive of the added equipment when the installation is completed and documented on the aircraft Weight and Balance Record (WBR). The ETX680-24-TSO battery weighs 7.2 pounds. When updating the weight and balance, use the same battery location / arm measurement as the original aircraft battery.

Reference Documents

Table 5 Reference Documents

ETX680-24-TSO-AFMS	FAA Approved Airplane Flight Manual Supplement (AFMS) for EarthX ETX680-24-TSO Battery

Regulations / Standards

This battery, is designed and tested to the following safety regulations as outlined in:

- FAA Technical Standard Order TSO-C179b
- FAA AC 20-184, Guidance on Testing and Installation of Rechargeable Lithium Battery and Battery Systems on Aircraft
- FAA AC 23.1309-1E, System Safety Analysis and Assessment for Part 23 Airplanes
- RTCA DO-160**G**, Environmental and Test Procedures for Airborne Equipment
- RTCA DO-254, Design Assurance Guidance for Airborne Electronic Hardware
- RTCA DO-311A, Minimum Operational Performance Standards for Rechargeable Lithium Batteries and Battery Systems
- UN 38.3, – United Nations ST/SG/AC.10/11/Rev.6, Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, Section 38.3, Lithium Metal and Lithium Ion Batteries.

Appendix A: Cessna 172 Models Installation Specific Information

Installation Drawing: ETX680-24-TSO-C172, *ETX680-24-TSO C172 Installation*